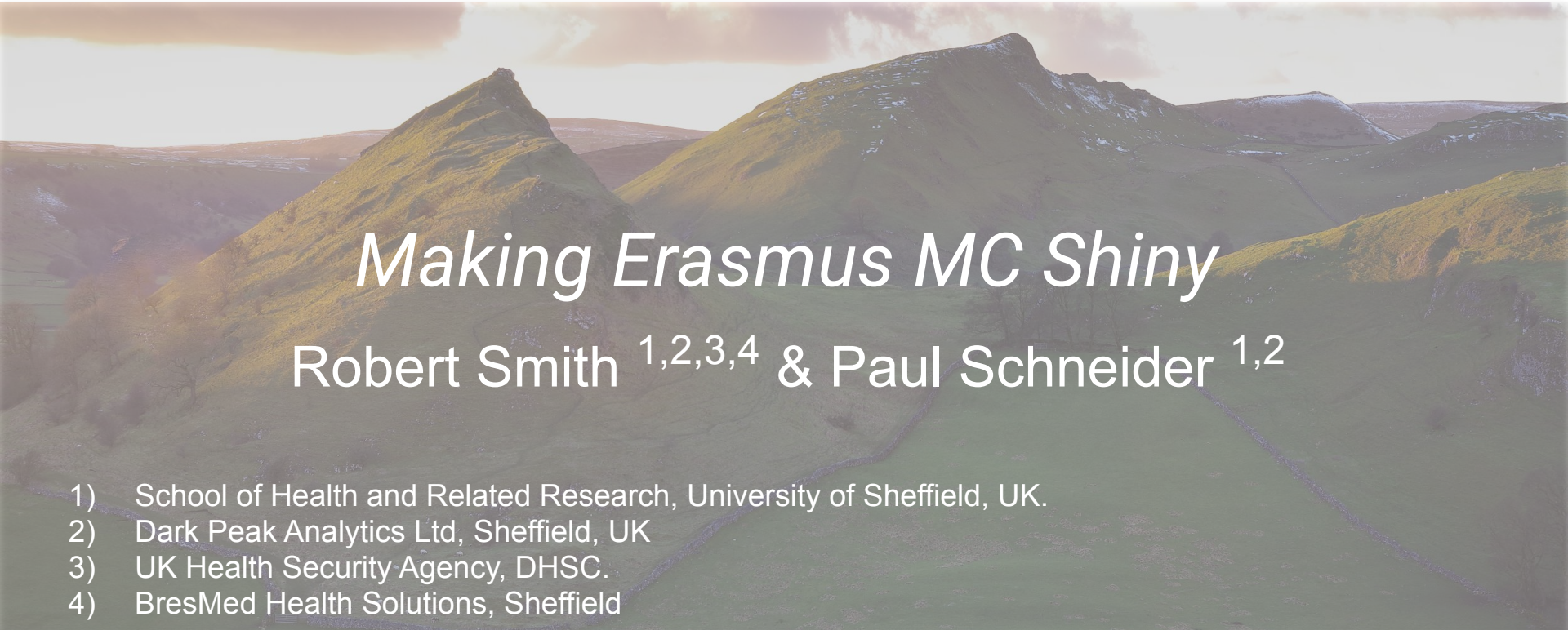


Making Erasmus MC Shiny

Robert Smith [1,2,3,4] & Paul Schneider [1,2]

1) School of Health and Related Research, University of Sheffield, UK.
2) Dark Peak Analytics Ltd, Sheffield, UK
3) UK Health Security Agency, DHSC.
4) BresMed Health Solutions, Sheffield

Before we start …

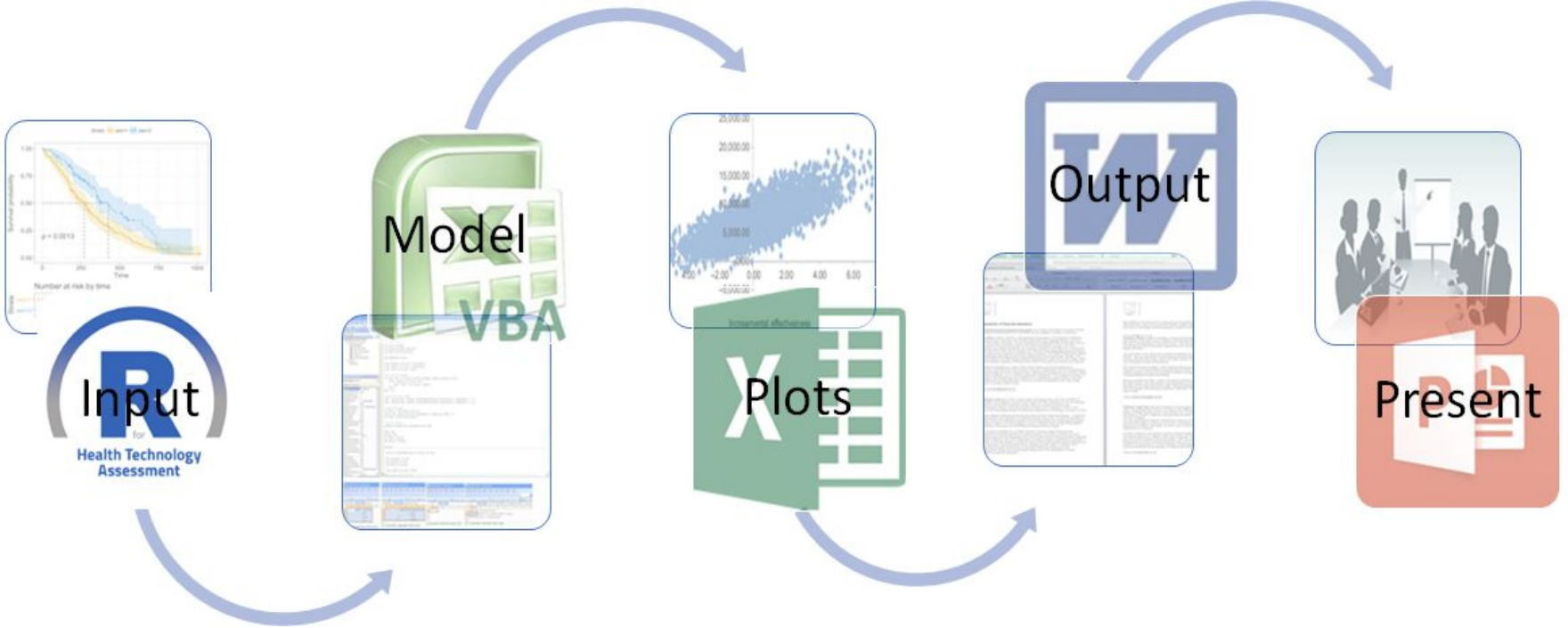
Disclaimer:

*The **views in this presentation are those of the author**, not of the University of Sheffield or the UK Health Security Agency.*

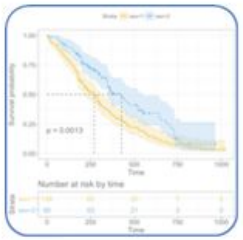
Grant information:

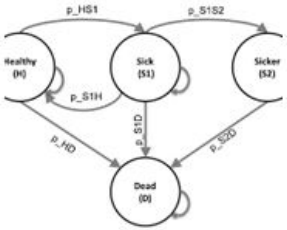
***R.S. and P.S. are joint funded by the Wellcome Trust** Doctoral Training Centre in Public Health Economics and Decision Science [108903] and the University of Sheffield.*

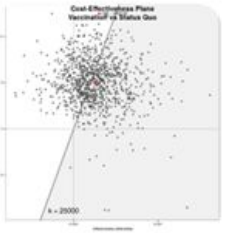
Current Process

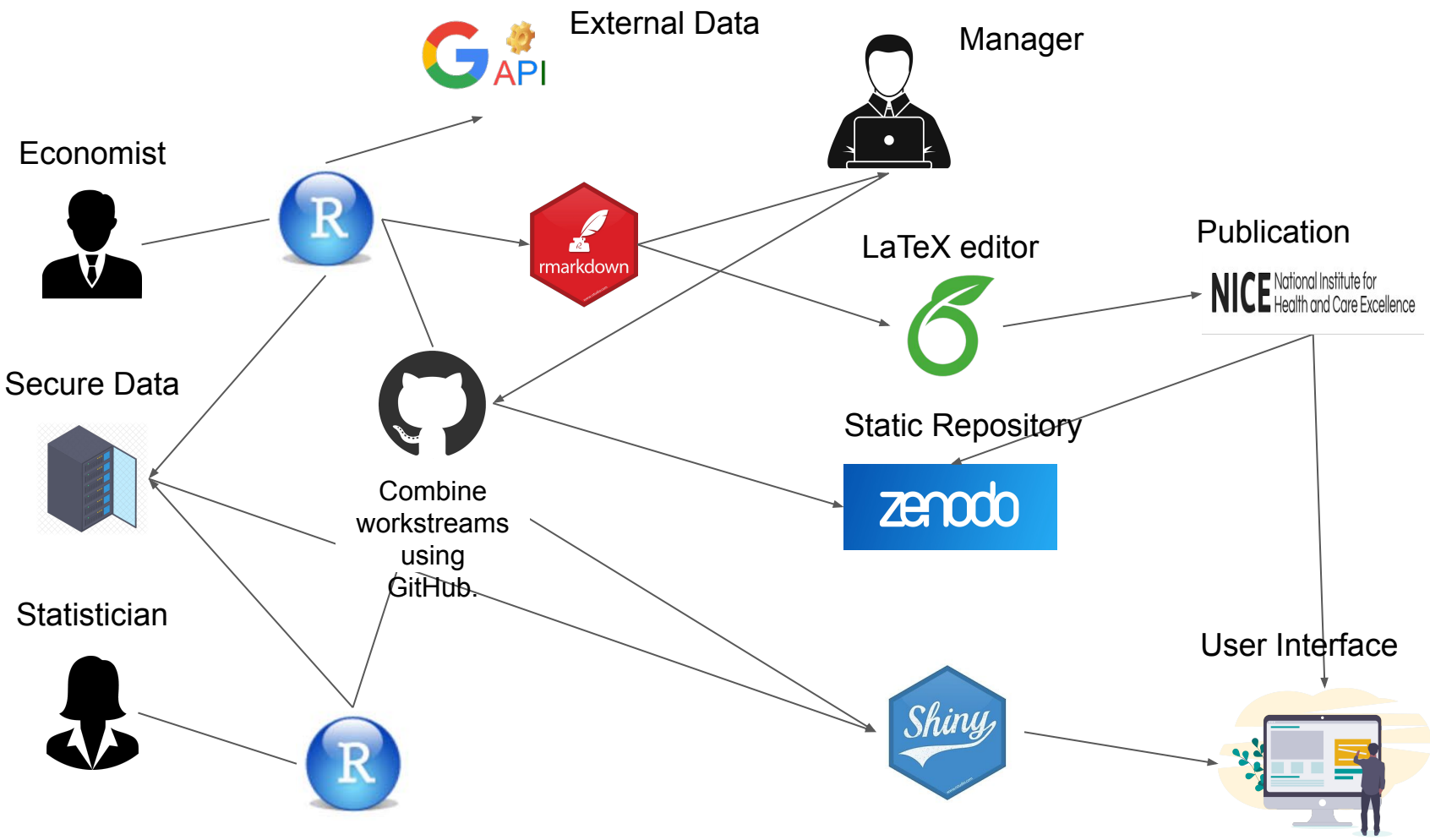


Future Process





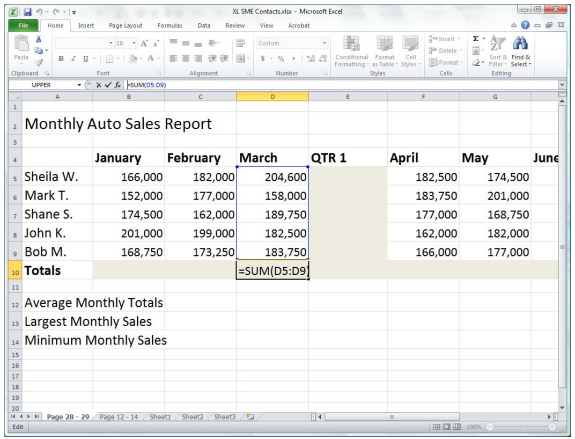


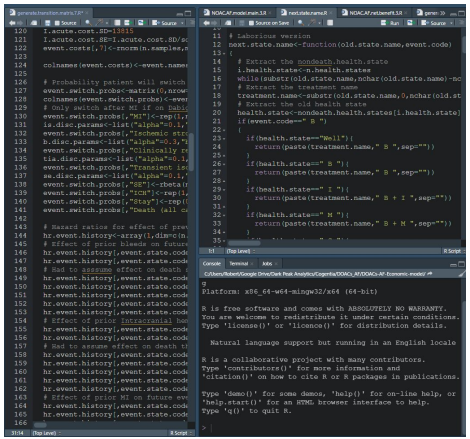

External Data
API
Manager
Economist
R
rmarkdown
LaTeX editor
Publication
NICE National Institute for Health and Care Excellence
Secure Data
Static Repository
zenodo
Combine workstreams using GitHub.
Statistician
R
Shiny
User Interface

Future Process: Benefits

1. One click update + transcription error reduction.
2. Speed of model creation (hence R not C++, time is money)!
3. Computational power (Rcpp) - VOI, analysis.
4. Code/data separation, testing independent of data.
5. Transparency - especially where publicly funded.
6. Reach & replication, one worldwide model on remote server.
7. Stakeholder engagement - Shiny + expert elicitation.

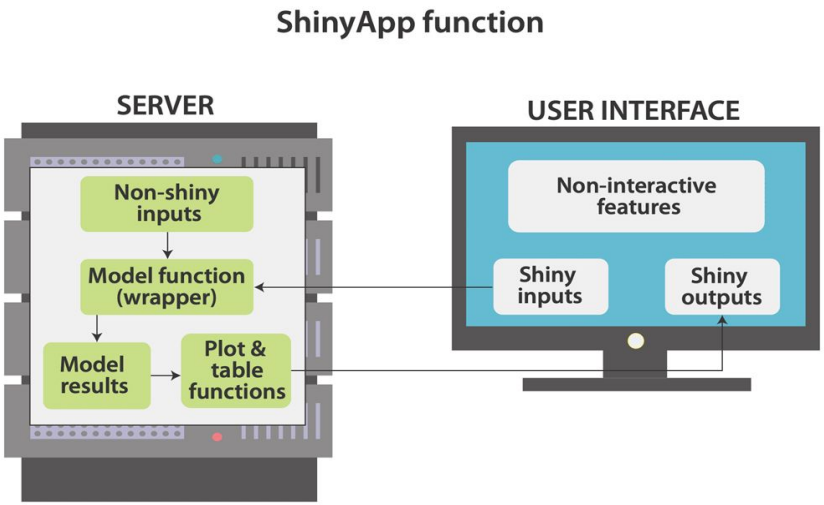
Graphical User Interface

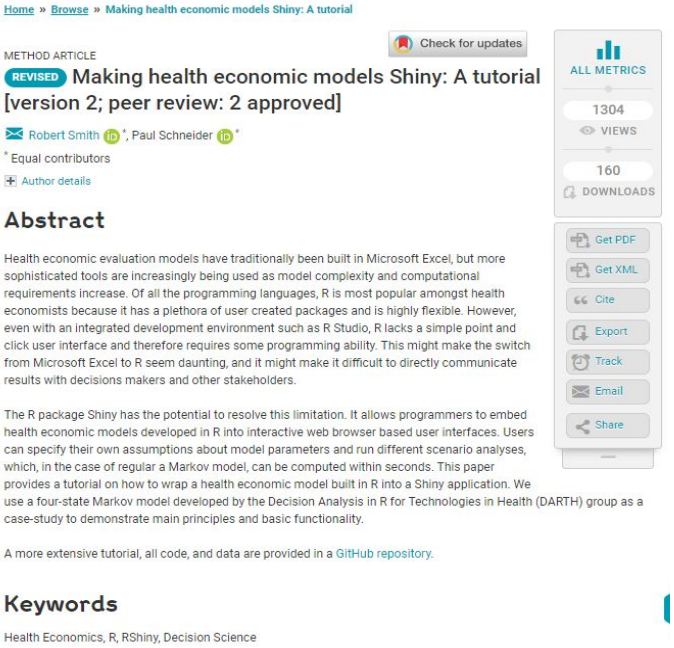




"... that code looks scary" (Anon, 2020)

Open-source tutorial





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METHOD ARTICLE

REVISED **Making health economic models Shiny: A tutorial [version 2; peer review: 2 approved]**

Robert Smith, Paul Schneider

Equal contributors

Author details

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Abstract

Health economic evaluation models have traditionally been built in Microsoft Excel, but more sophisticated tools are increasingly being used as model complexity and computational requirements increase. Of all the programming languages, R is most popular amongst health economists because it has a plethora of user created packages and is highly flexible. However, even with an integrated development environment such as R Studio, R lacks a simple point and click user interface and therefore requires some programming ability. This might make the switch from Microsoft Excel to R seem daunting, and it might make it difficult to directly communicate results with decisions makers and other stakeholders.

The R package Shiny has the potential to resolve this limitation. It allows programmers to embed health economic models developed in R into interactive web browser based user interfaces. Users can specify their own assumptions about model parameters and run different scenario analyses, which, in the case of regular a Markov model, can be computed within seconds. This paper provides a tutorial on how to wrap a health economic model built in R into a Shiny application. We use a four-state Markov model developed by the Decision Analysis in R for Technologies in Health (DARTH) group as a case-study to demonstrate main principles and basic functionality.

A more extensive tutorial, all code, and data are provided in a GitHub repository.

Keywords

Health Economics, R, RShiny, Decision Science

Paper: https://wellcomeopenresearch.org/articles/5-69
Code: https://github.com/RobertASmith/healthecon_shiny

Simple app

Sick Sicker Model in Shiny

Treatment Cost

200

PSA runs

1000

initial age

10 25 80

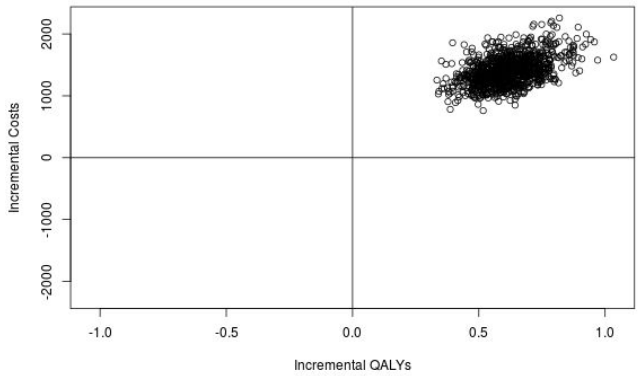
10 17 24 31 38 45 52 59 66 73 80

Run / update model

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.59	100441.67	0.62	1406.24	2324.54
No Treatment	17.97	99035.43	NA	NA	NA

Cost-effectiveness Plane



https://robertasmith.shinyapps.io/sick_sicker

Open-source tutorial

Inputs → Function → Outputs

Parameters		
c_s1	cost1	3
c_s2	cost2	5
c_H	cost3	6
dr	Dis_rate	0.035
n_sim	No. psa	1000

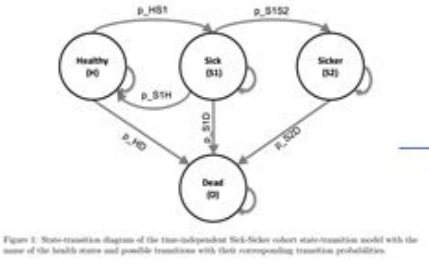
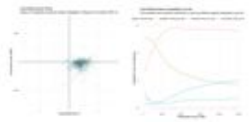


Figure 1: State-transition diagram of the time-independent Sick-Sicker cohort state-transition model with the name of the health states and possible transitions with their corresponding transition probabilities.

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.56	101106.37	0.63	1422.23	2320.60
No Treatment	17.93	99684.14	N/A	N/A	N/A



Open-source tutorial

Inputs → Function → Outputs

Parameters		
c_s1	cost1	3
c_s2	cost2	5
c_H	cost3	6
dr	Dis_rate	0.035
n_sim	No. psa	1000

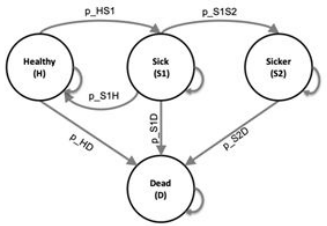


Figure 1: State-transition diagram of the time-independent Sick-Sicker cohort state-transition model with the name of the health states and possible transitions with their corresponding transition probabilities.

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
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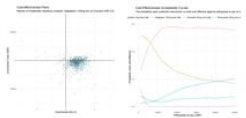
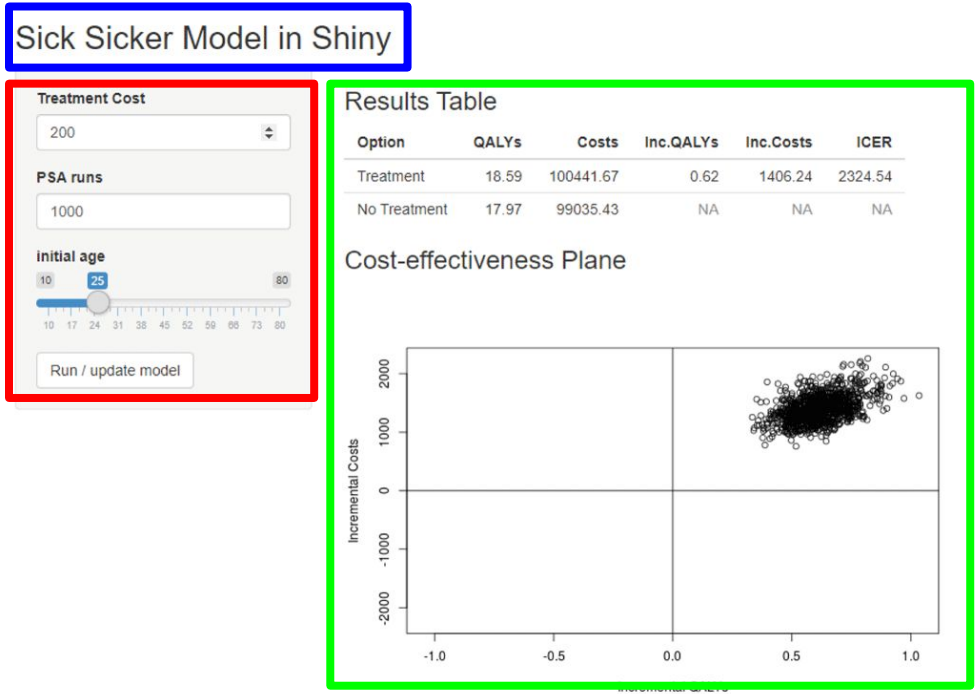


Shiny

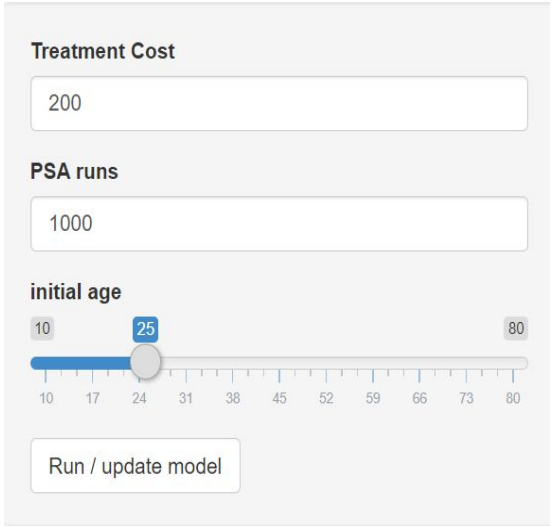
UI code

```
ui <- fluidPage (     # creates empty page

  # title of app
  titlePanel("Sick Sicker Model in Shiny"),

   # layout is a sidebar-layout
   sidebarLayout(

  # open sidebar panel

      < SIDEBAR PANEL CODE >

# open main panel

      < MAIN PANEL CODE >

         )# close sidebarlayout

) # close UI fluidpage
```



Sidebar Panel Code

```
sidebarPanel( # open sidebar panel

    numericInput(inputId = "SI_c_Trt",
                 label = "Treatment Cost",
                 value = 200,
                 min = 0,
                 max = 400),

    numericInput(inputId = "SI_n_sim",
                 label = "PSA runs",
                 value = 1000,
                 min = 0,
                 max = 400),

    sliderInput(inputId = "SI_n_age_init",
                label = "Initial Age",
                value = 25,
                min = 10,
                max = 80),

    # action button runs model when pressed
    actionButton(inputId = "run_model",
                 label   = "Run model")

 )  # close sidebarPanel
```



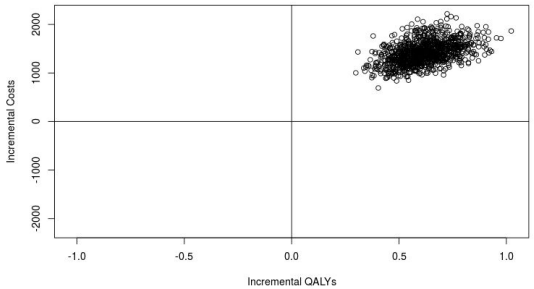
Main Panel Code

```
  mainPanel(

# heading (results table)
    h3("Results Table"),

# tableOutput id = icer_table, from server
    tableOutput(outputId = "SO_icer_table"),

# heading (Cost effectiveness plane)
    h3("Cost-effectiveness Plane"),

# plotOutput id = SO_CE_plane, from server
    plotOutput(outputId = "SO_CE_plane")

            )  # close mainpanel
```

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.61	101016.42	0.62	1412.82	2335.56
No Treatment	17.99	99603.60	NA	NA	NA

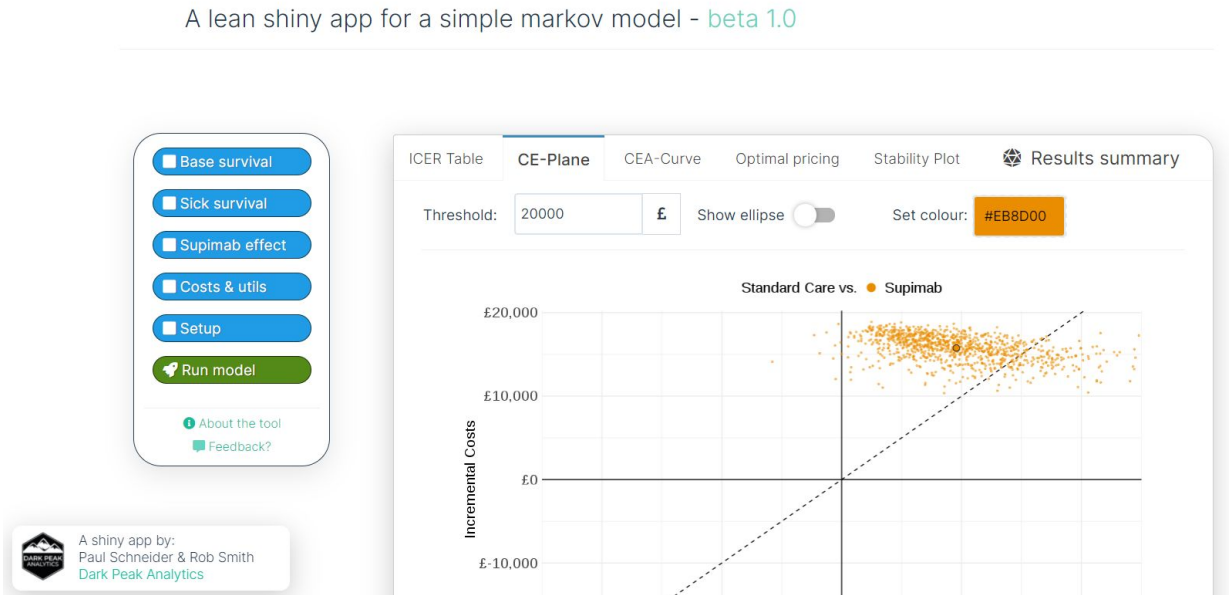
Cost-effectiveness Plane



Server Code

```
server <- function(input, output){

 observeEvent(input$run_model, # WHEN ACTION BUTTON PRESSED
               ignoreNULL = F, {

# Run  model function with Shiny inputs
 df_model_res = f_wrapper(c_Trt = input$SI_c_Trt,
                          n_age_init = input$SI_n_age_init,
                          n_sim = input$SI_n_sim)

#-- CREATE COST EFFECTIVENESS TABLE --#
# renderTable continuously updates table
 output$SO_icer_table <- renderTable({  < ICER TABLE FUNCTION >    }) # table plot end.

#-- CREATE COST EFFECTIVENESS PLANE --#
# render plot repeatedly updates.
output$SO_CE_plane <- renderPlot({     < CE PLANE FUNCTION >  }) # renderplot end

}) # Observe event end

} # Server end
```

More sophisticated app



https://darkpeakanalytics.shinyapps.io/sadm-mk2/

Open-source materials

Simple materials:

App: https://robertasmith.shinyapps.io/sick_sicker/
Paper: https://wellcomeopenresearch.org/articles/5-69
Code: https://github.com/RobertASmith/paper_makeHEshiny
Tutorial: https://r-hta.org/tutorial/markov_models_shiny/

More advanced materials:

App: https://darkpeakanalytics.shinyapps.io/sadm-mk2/
Code: https://github.com/bitowaqr/sadm-mk2
Package: https://github.com/RobertASmith/darkpeak

Thanks from Sheffield

Git: https://github.com/RobertASmith
Web: https://www.darkpeakanalytics.com/
Email: rasmith3@sheffield.ac.uk
LinkedIn: https://www.linkedin.com/in/robert-smith-53b28438/